



## **NATIONAL TRANSPORTATION SAFETY BOARD**

Office of Aviation Safety  
Washington, D.C. 20594

August 3, 2017

### **Weather Study**

# **METEOROLOGY**

ERA17FA181

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## **A. ACCIDENT**

Location: Near Eleuthera, Bahamas  
Date: May 15, 2017  
Time: 1339 eastern daylight time  
1739 Coordinated Universal Time (UTC)  
Airplane: MU-2B, registration: N220N

## **B. METEOROLOGIST**

Paul Suffern  
Senior Meteorologist  
Operational Factors Division (AS-30)  
National Transportation Safety Board

## **C. DETAILS OF THE INVESTIGATION**

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are eastern daylight time (EDT) on May 15, 2017, and are based upon the 24-hour clock, where local time is -4 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident upset location was at approximate latitude 25.200° N and longitude 75.967° W at approximate altitude of FL240<sup>1</sup>.

## **D. WEATHER INFORMATION**

### **1.0 Synoptic Situation**

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H.

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<sup>1</sup> Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

## 1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1400 EDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart depicted a stationary front located in the eastern Gulf of Mexico stretching eastward into the northwestern Atlantic Ocean with the accident site located directly coincident with the stationary front. A surface high pressure system was located in the northwestern Atlantic Ocean near the coast of Georgia and South Carolina with a pressure of 1016-hectopascals (hPa). The station models around the accident site depicted air temperatures in the upper 70's to lower 80's degrees Fahrenheit (°F), dew point temperatures in the low 70's °F, variable winds under 5 knots, and mostly cloudy skies with light rain. Areas near frontal boundaries are favored locations for enhanced vertical motion, clouds, and precipitation.

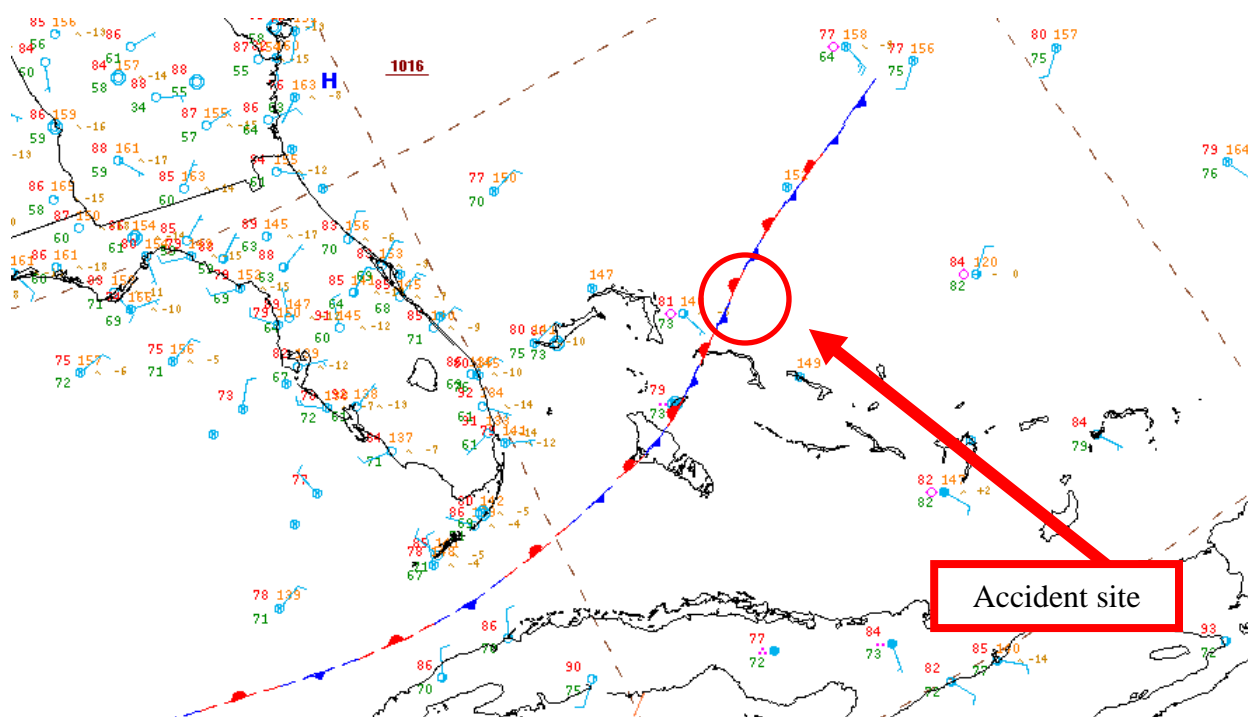


Figure 1 – NWS Surface Analysis Chart for 1400 EDT

## 1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0800 EDT at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. The accident site was located east of a mid-level trough<sup>2</sup> at 700-hPa (figure 4). Areas near troughs are favored locations for enhanced vertical motion, clouds, and precipitation. This trough was likely the initial starting point of many of the thunderstorms and rain showers on May 15 seen in the weather satellite imagery (section 5.0). There was a southwest to west wind under 15 knots from 925-hPa (figure 2) through 700-hPa (figure 4). By 500-hPa, the wind became westerly at 25 knots (figure 5) with a 65 knot west wind by 300-hPa (figure 6).

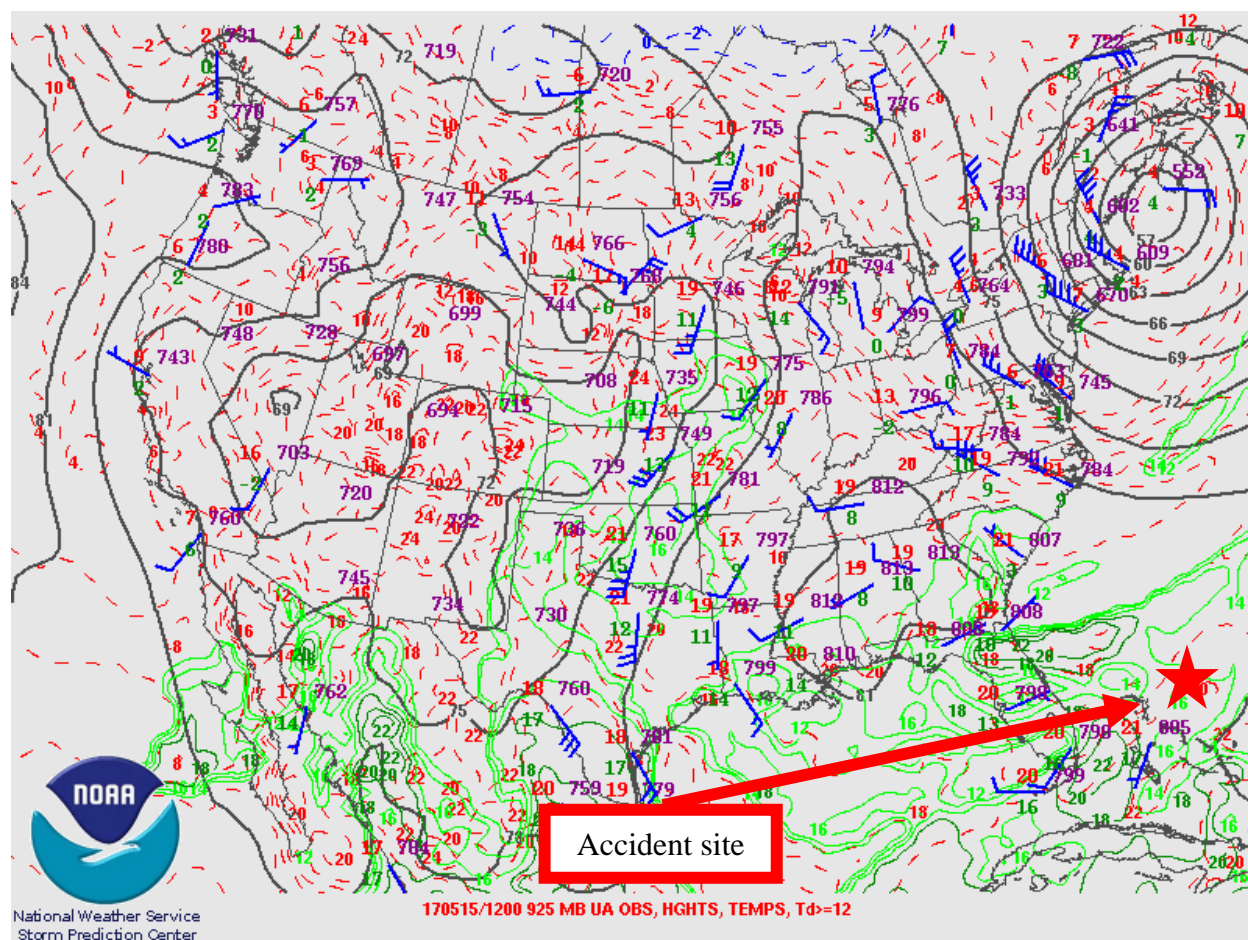


Figure 2 – 925-hPa Constant Pressure Chart for 0800 EDT

<sup>2</sup> Trough – An elongated area of relatively low atmospheric pressure or heights.

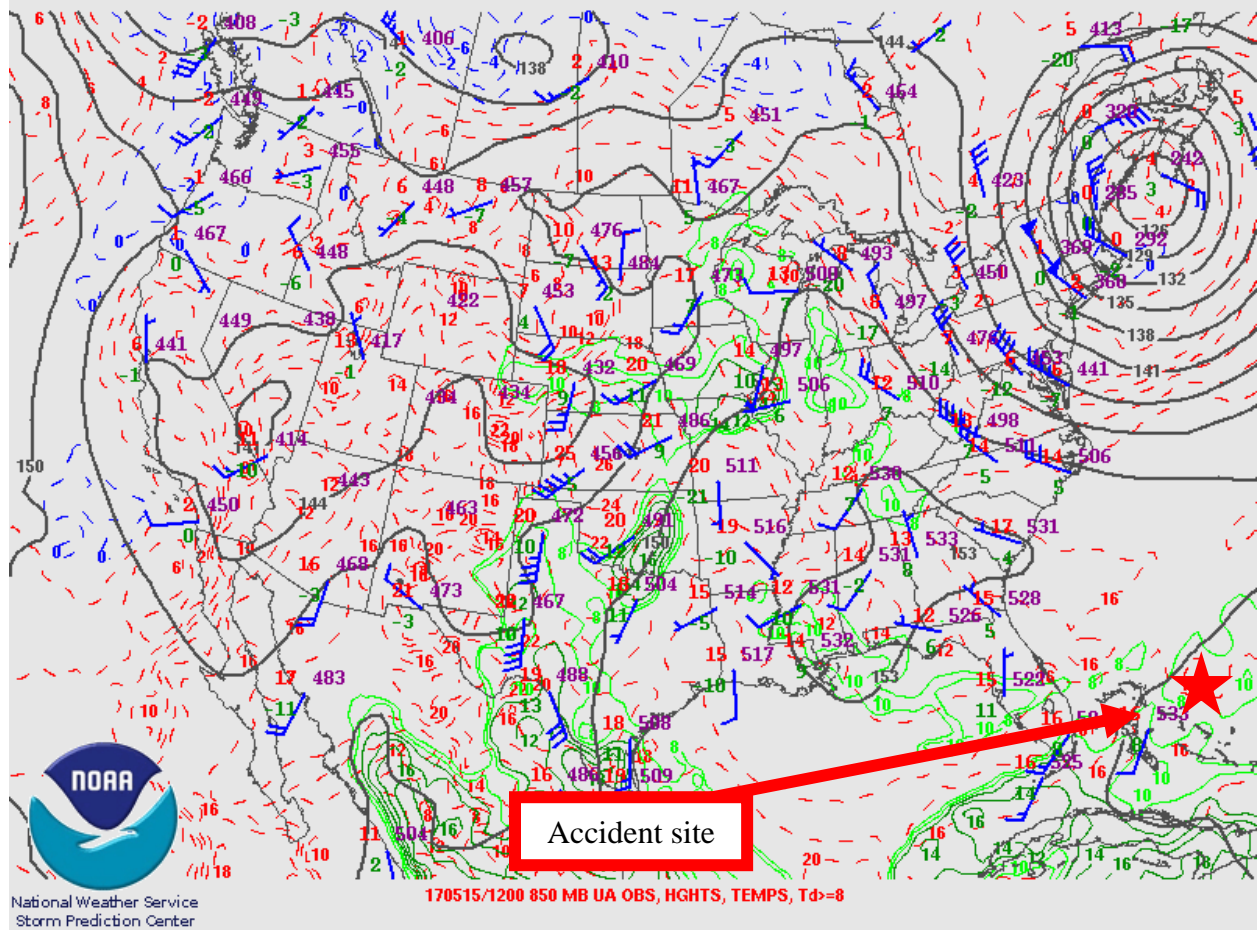
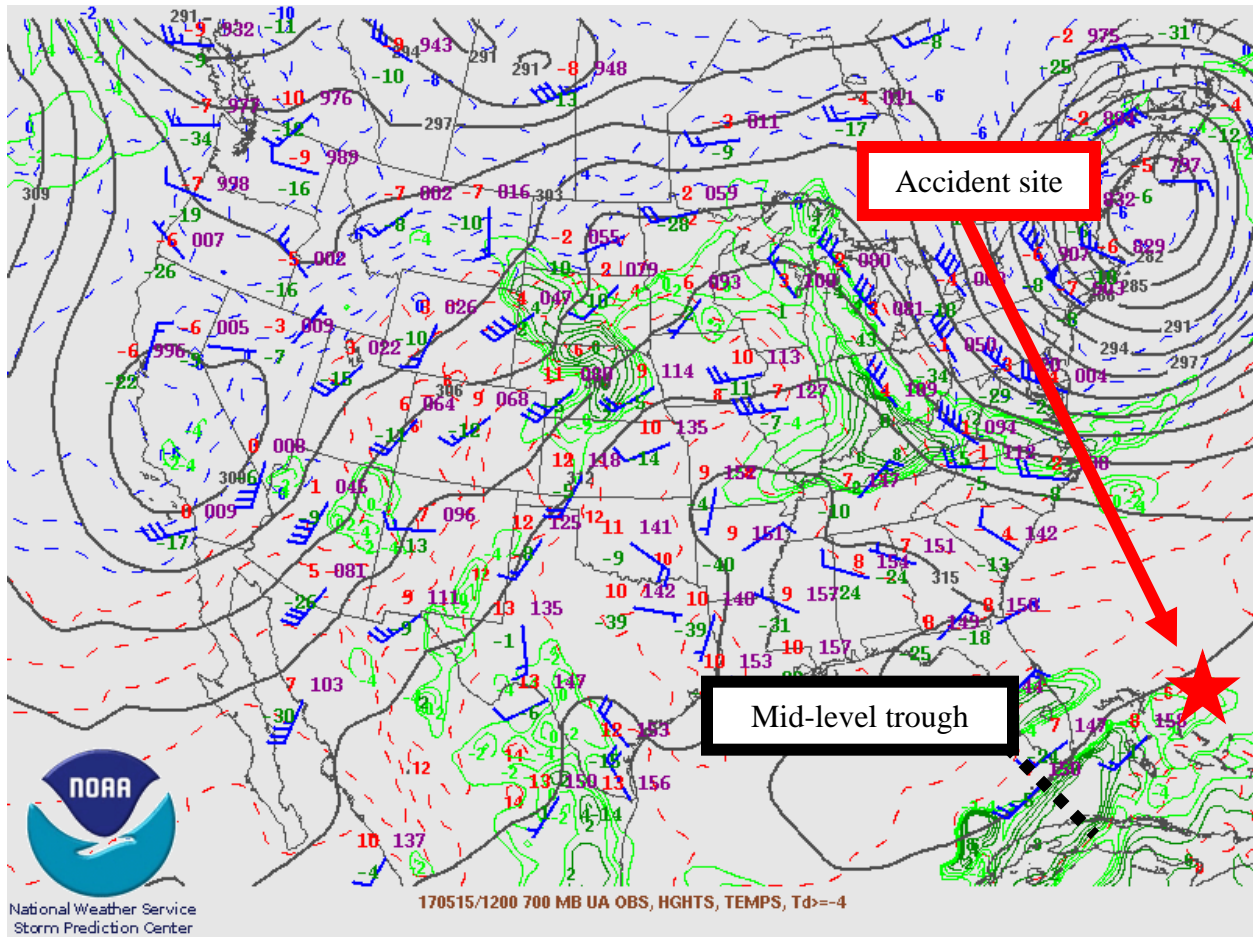
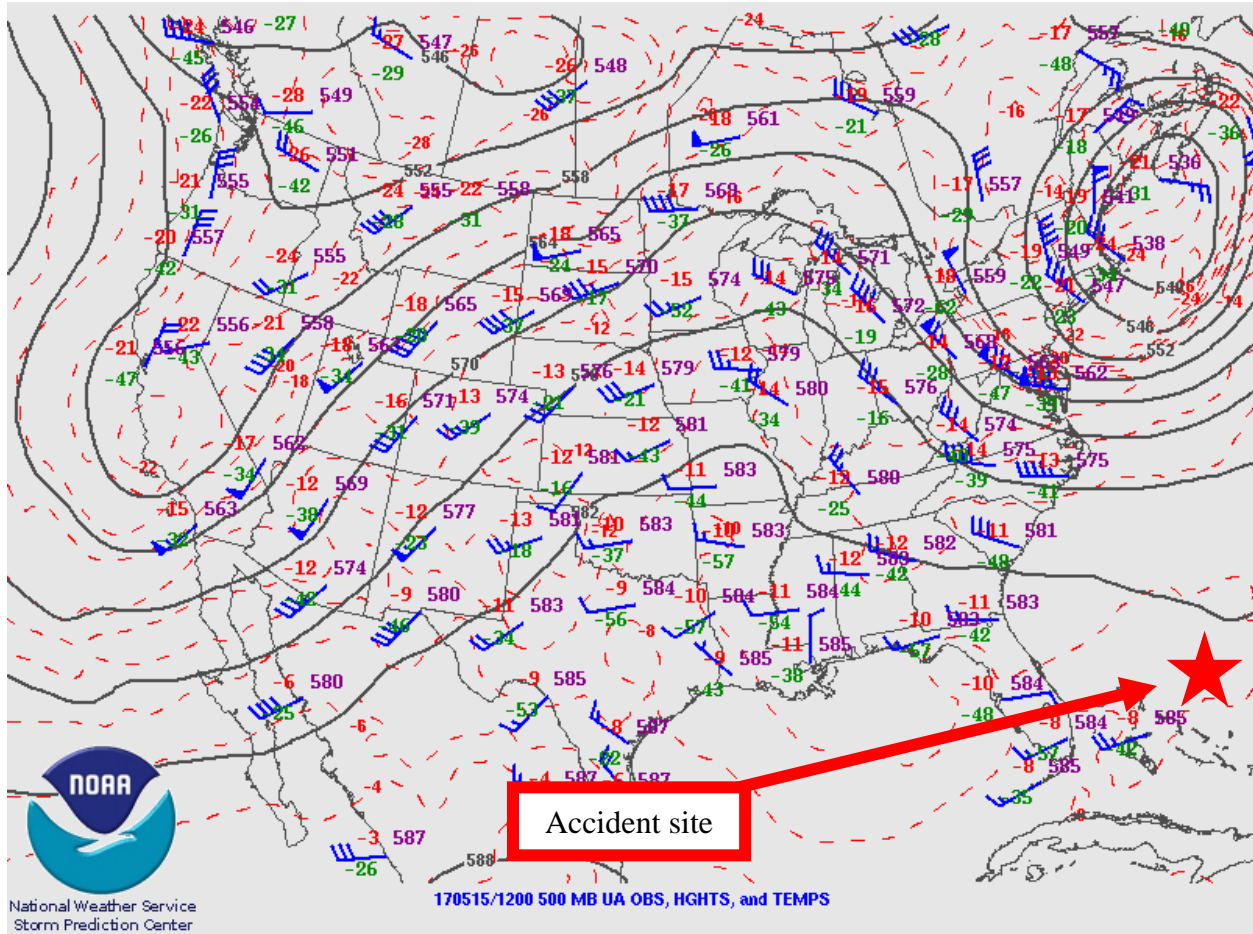


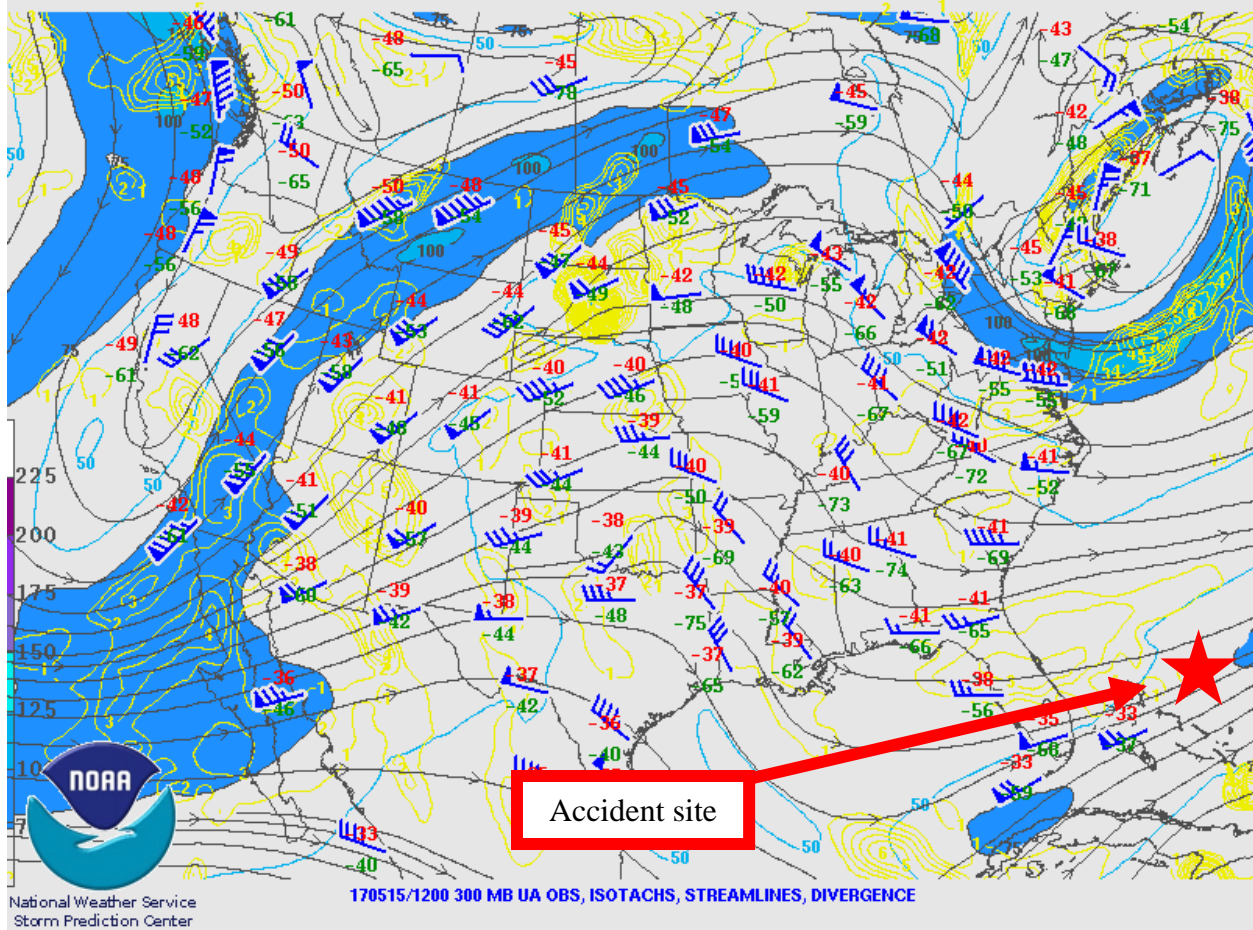
Figure 3 – 850-hPa Constant Pressure Chart for 0800 EDT



**Figure 4 – 700-hPa Constant Pressure Chart for 0800 EDT**



**Figure 5 – 500-hPa Constant Pressure Chart for 0800 EDT**



**Figure 6 – 300-hPa Constant Pressure Chart for 0800 EDT**

## 2.0 SPC Products

The accident site was located outside of the forecast area for SPC forecast products.

## 3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 7 is a sectional chart with the accident site and the closest weather reporting location marked.



**Figure 7 – Sectional chart of accident area with the location of the accident site and surface observation site**

Lynden Pindling International Airport (MYNN) was the closest official weather station to the accident site and was located 7 miles west of Nassau, Bahamas. MYNN had an official weather observer at the airport reporting weather observation. MYNN was located 82 miles west of the accident site, at an elevation of 16 feet, and had an 8° westerly magnetic variation<sup>3</sup> (figure 7). The following observations were taken and disseminated during the times surrounding the accident:<sup>4</sup>

[0700 EDT] METAR MYNN 151100Z 00000KT 9999 FEW020 BKN035 BKN100 25/22 A2993=

[0800 EDT] METAR MYNN 151200Z 00000KT 9999 FEW020 BKN035 BKN100 27/24 A2995=

[0900 EDT] METAR MYNN 151300Z 00000KT 9999 FEW020 BKN035 BKN100 29/23 A2996=

<sup>3</sup> Magnetic variation – The angle (at a particular location) between magnetic north and true north. 2010, latest measurement taken from <http://www.airnav.com/airport/MYNN>

<sup>4</sup> Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

[1000 EDT] METAR MYNN 151400Z 00000KT 9999 FEW016CB BKN035 BKN100 28/24 A2998 RMK CB/W=

[1100 EDT] METAR MYNN 151500Z 00000KT TSRA 1600 SCT012CB BKN030 OVC100 28/24 A2999 RMK CB SCT ALQDS=

**[1200 EDT] METAR MYNN 151600Z 00000KT TSRA 6000 SCT012CB BKN030 OVC100 24/21 A2999 RMK CB SCT ALQDS=**

**[1300 EDT] METAR MYNN 151700Z 13005KT -RA 9000 SCT012CB BKN030 OVC100 24/21 A2998 RMK CB SCT ALQDS=**

**ACCIDENT TIME 1339 EDT**

**[1400 EDT] METAR MYNN 151800Z 00000KT -RA 9000 SCT012CB BKN030 OVC100 26/23 A2997 RMK CB SCT ALQDS=**

**[1500 EDT] METAR MYNN 151900Z 00000KT 9999 SCT018CB BKN030 OVC100 28/21 A2995 RMK CB SCT ALQDS=**

[1600 EDT] METAR MYNN 152000Z 12004KT 9999 SCT018 BKN030 OVC100 28/20 A2993=

[1700 EDT] METAR MYNN 152100Z 00000KT 9999 FEW018 SCT030 BKN080 28/19 A2992=

MYNN weather at 1200 EDT, wind calm, thunderstorms and moderate rain, 6 kilometers (km)<sup>5</sup> visibility, scattered cumulonimbus clouds at 1,200 feet above ground level (agl), broken ceiling at 3,000 feet agl, overcast skies at 10,000 feet agl, temperature of 24° Celsius (C), dew point temperature of 21° C, and an altimeter setting of 29.99 inches of mercury. Remarks, cumulonimbus clouds scattered all quadrants.

MYNN weather at 1300 EDT, wind from 130° at 5 knots, light rain, 9 km<sup>6</sup> visibility, scattered cumulonimbus clouds at 1,200 feet agl, broken ceiling at 3,000 feet agl, overcast skies at 10,000 feet agl, temperature of 24° C, dew point temperature of 21° C, and an altimeter setting of 29.98 inches of mercury. Remarks, cumulonimbus clouds scattered all quadrants.

MYNN weather at 1400 EDT, wind calm, light rain, 9 km visibility, scattered cumulonimbus clouds at 1,200 feet agl, broken ceiling at 3,000 feet agl, overcast skies at 10,000 feet agl, temperature of 26° C, dew point temperature of 23° C, and an altimeter setting of 29.97 inches of mercury. Remarks, cumulonimbus clouds scattered all quadrants.

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<sup>5</sup> 6 km ≈ 3.7 statute miles

<sup>6</sup> 9 km ≈ 5.6 statute miles

MYNN weather at 1500 EDT, wind calm, 10 km<sup>7</sup> or greater visibility, scattered cumulonimbus clouds at 1,800 feet agl, broken ceiling at 3,000 feet agl, overcast skies at 10,000 feet agl, temperature of 28° C, dew point temperature of 21° C, and an altimeter setting of 29.95 inches of mercury. Remarks, cumulonimbus clouds scattered all quadrants.

The observations from MYNN surrounding the accident time indicated MVFR<sup>8</sup> conditions near MYNN with thunderstorms, light rain, and relatively light surface wind conditions.

#### 4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)<sup>9</sup> model sounding was created for the accident site for 1400 EDT. The 1400 EDT sounding was plotted on a standard Skew-T log P diagram<sup>10</sup> with the derived stability parameters included in figure 8 (with data from the surface to 200-hPa, or 39,000 feet msl.) This sounding data was analyzed utilizing the RAOB<sup>11</sup> software package. The sounding depicted the lifted condensation level (LCL)<sup>12</sup> at 849 feet msl, a convective condensation level (CCL)<sup>13</sup> of 4,678 feet, and a level of free convection (LFC)<sup>14</sup> at 1,782 feet. The freezing level was at 13,725 feet. The precipitable water value was 1.95 inches.

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<sup>7</sup> 10 km  $\approx$  6.2 statute miles

<sup>8</sup> Marginal Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. MVFR criteria means a ceiling between 1,000 and 3,000 feet agl inclusive and/or 3 to 5 miles visibility.

<sup>9</sup> The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three kilometer grids with three kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one hour period.

<sup>10</sup> Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

<sup>11</sup> RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

<sup>12</sup> LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

<sup>13</sup> CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

<sup>14</sup> LFC – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.



There was 2,612 J/kg of CAPE<sup>16</sup>. This environment would have been supportive of cloud formation and precipitation, if a lifting mechanism were in the area of the accident site at the accident time (sections 1.1 and 1.2). The Maximum vertical velocity (MVV) for this atmosphere was calculated as 72 meters/second (about 14,173 feet per minute).<sup>17</sup> Downdraft CAPE (DCAPE; 6 kilometers agl)<sup>18</sup> was measured at 379 Joules/kilogram.

The 1400 EDT HRRR sounding wind profile indicated a surface wind from 246° at 2 knots with the wind remaining variable and under 10 knots through 10,000 feet. The wind became southwesterly to westerly by 15,000 feet and increased in speed to 15 knots. The wind was westerly at 30 knots around 25,000 feet and continued to increase in speed through 39,000 feet to 75 knots. RAOB indicated no possibility low-level wind shear outside of the thunderstorm or rain shower activity. Light to moderate clear-air turbulence was indicated by RAOB outside of the thunderstorm and rain showers activity in several layers between 8,000 and 39,000 feet.

## 5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-13 bands 1 and 4) at wavelengths of 0.65 microns ( $\mu\text{m}$ ) and 10.7  $\mu\text{m}$ , respectively, were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1100 EDT through 1700 EDT at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

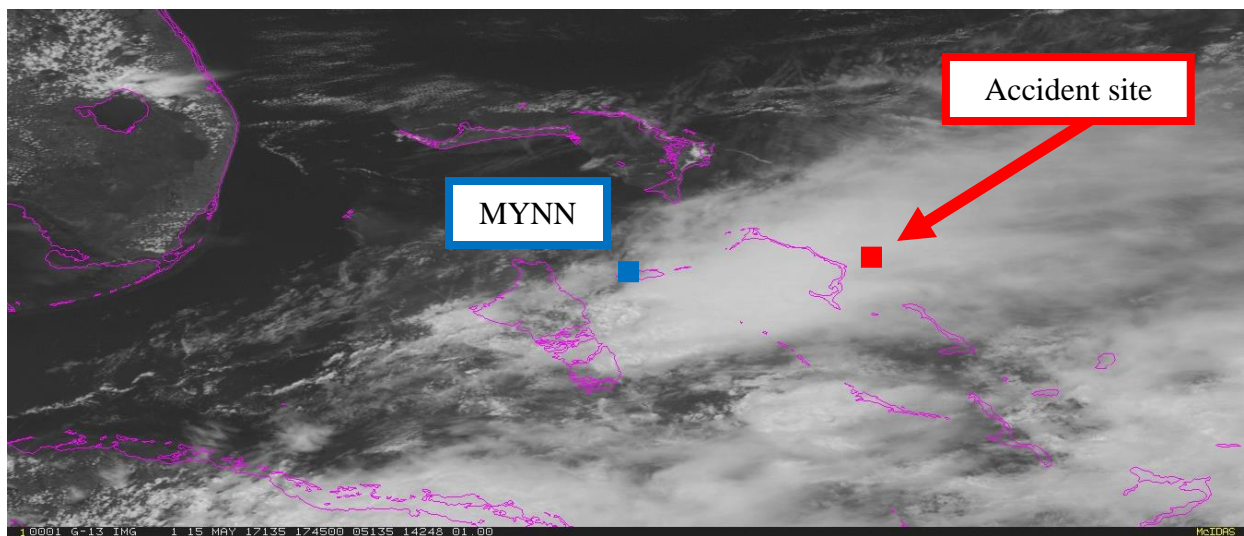
Figures 9 and 10 present the GOES-13 visible imagery from 1345 and 1415 EDT at 1X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated abundant clouds over the accident site at the accident time with the cloud cover moving from west to east (attachment 1). Figure 11 presents the GOES-13 infrared imagery from 1345 EDT at 3X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated abundant clouds over the accident site at the accident time with the cloud cover moving from west to east (attachment 2). The lower brightness temperatures (blue and green colors, higher cloud tops) were over the accident site at the accident time. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1400 EDT HRRR sounding, the approximate cloud-top heights over the accident site were estimated at 40,000 feet at 1345 EDT (figure 11). It should be noted these figures have not been corrected for any parallax error.

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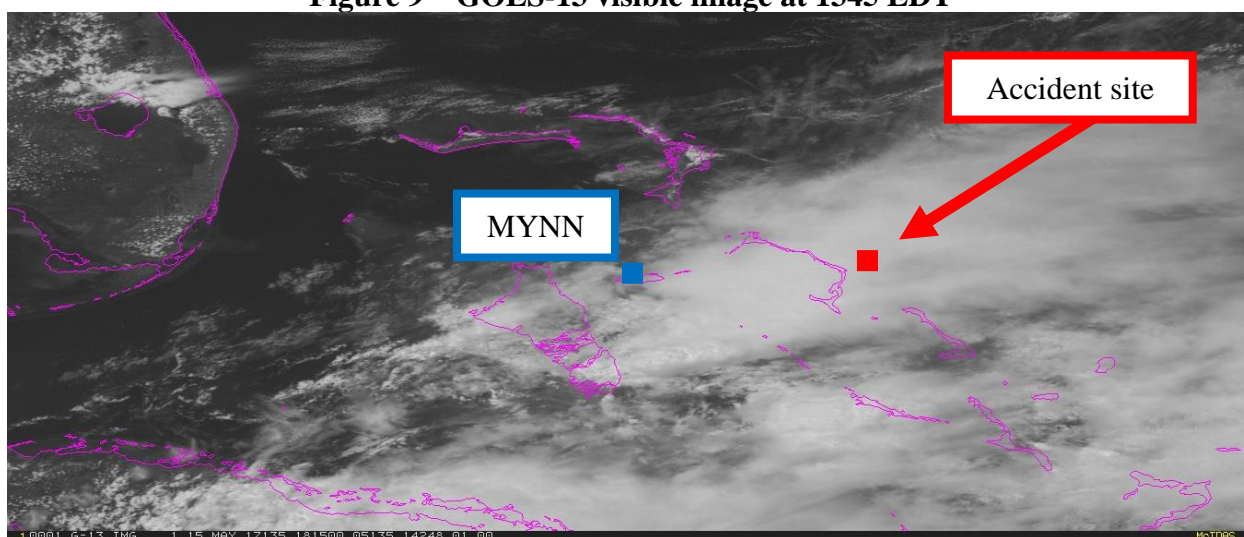
<sup>16</sup> Convective Available Potential Energy (CAPE) – CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.

<sup>17</sup> MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

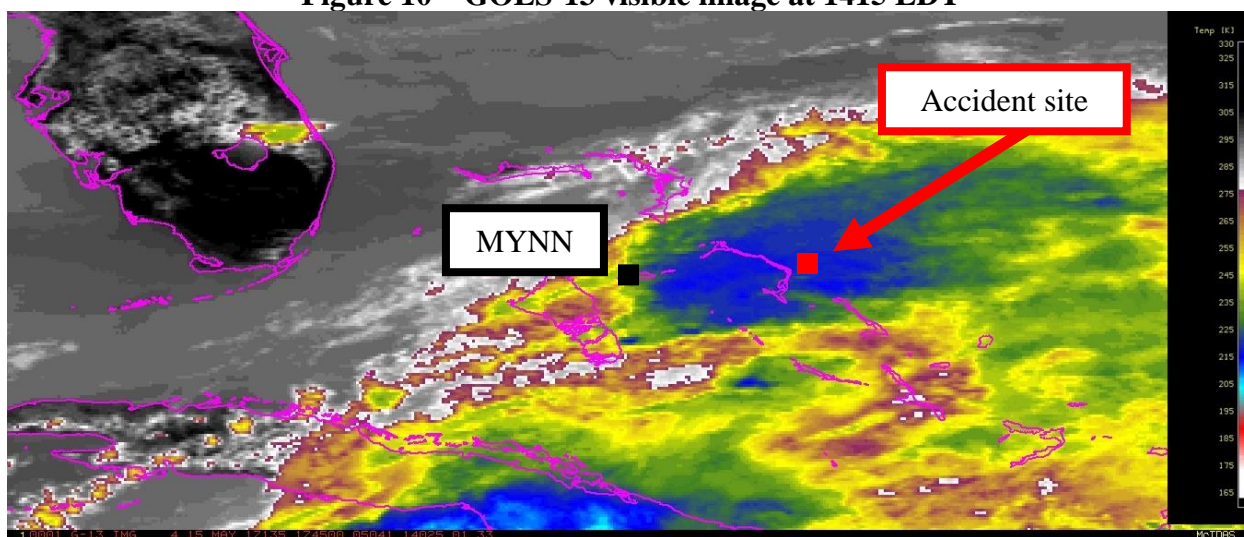
<sup>18</sup> The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts.



**Figure 9 – GOES-13 visible image at 1345 EDT**



**Figure 10 – GOES-13 visible image at 1415 EDT**



**Figure 11 – GOES-13 infrared image at 1345 EDT**

## 6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)<sup>19</sup> to the accident site was the Miami, Florida, radar (KAMX), which was located 242 miles west of the accident site at an elevation of 13 feet. Level II and III archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software. KAMX was located too far away to detect any precipitation targets at the accident site at the accident time. There were no lightning strikes around the accident site at the accident time.<sup>20</sup>

## 7.0 Pilot Reports<sup>21</sup>

All pilot reports (PIREPs) within 200 nautical miles of the accident site from three hours prior to the accident time to three hours after the accident time were reviewed. The PIREPs that were publically disseminated are provided below:

MYNN UA /OV ZQA040075/TM 1740/FL250/TP B738/TA M23/IC LGT-MOD RIME/RM CWSU ZMA

MIA UA /OV ZQA260050/TM 1800/FL300/TP A319/TB MOD/RM CWSU ZMA=

MYNN UA /OV ZQA158132/TM 1819/FL280/TP B350/TA M17/IC LGT RIME/RM CWSU ZMA=

MYNN UA /OV ZQA242149/TM 1921/FL280/TP D328/TA M23/IC LGT RIME/RM CWSU ZMA=

MYNN UUA /OV ZQA135095/TM 2003/FL370/TP B738/TB SEV/RM NO DAMAGE/NO INJURIES CWSU ZMA=

Routine pilot report (UA); 75 miles from Nassau, Bahamas, on the 040° radial; Time – 1340 EDT (1740Z); Altitude – FL250; Type aircraft – Boeing B737-800; Temperature – -23° C; Icing – Light to moderate rime.

Routine pilot report (UA); 50 miles from Nassau, Bahamas, on the 260° radial; Time – 1400 EDT (1800Z); Altitude – FL300; Type aircraft – Airbus A319; Turbulence – Moderate.

Routine pilot report (UA); 132 miles from Nassau, Bahamas, on the 158° radial; Time – 1419 EDT (1819Z); Altitude – FL280; Type aircraft – Beechcraft Super King Air; Temperature – -17° C; Icing – Light rime.

Routine pilot report (UA); 149 miles from Nassau, Bahamas, on the 242° radial; Time – 1521 EDT (1921Z); Altitude – FL280; Type aircraft – Dornier 328; Temperature – -23° C; Icing – Light rime.

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<sup>19</sup> The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

<sup>20</sup> A review of the Earth Networks Total Lightning Network was performed.

<sup>21</sup> Only pilot reports with the WMO header UBFL\*\* and MYNN\*\* identifier were considered.

Urgent pilot report (UUA); 95 miles from Nassau, Bahamas, on the 135° radial; Time – 1603 EDT (2003Z); Altitude – FL370; Type aircraft – Boeing B737-800; Turbulence – Severe; Remarks – No damage, no injuries.

## 8.0 SIGMET and CWSU Advisories

No Center Weather Service Unit (CWSU) Center Weather Advisories or Meteorological Impact Statements were valid for the accident site at the accident time.

A Significant Meteorological Information (SIGMET) advisory was valid for the accident site at the accident time. The SIGMET was issued at 1300 EDT and valid through 1700 EDT and warned of thunderstorms with tops to FL440 and that the thunderstorms were moving eastward at 25 knots:

WSNT05 KPCI 151700

SIGA0E

**KZMA SIGMET ECHO 2 VALID 151700/152100 KPCI-**

**MIAMI OCEANIC FIR FRQ TS OBS AT 1700Z WI N2600 W07645 - N2445**

**W07530 - N2400 W07745 - N2445 W07830 - N2600 W07645. TOP FL440.**

**MOV E 25KT. NC.**

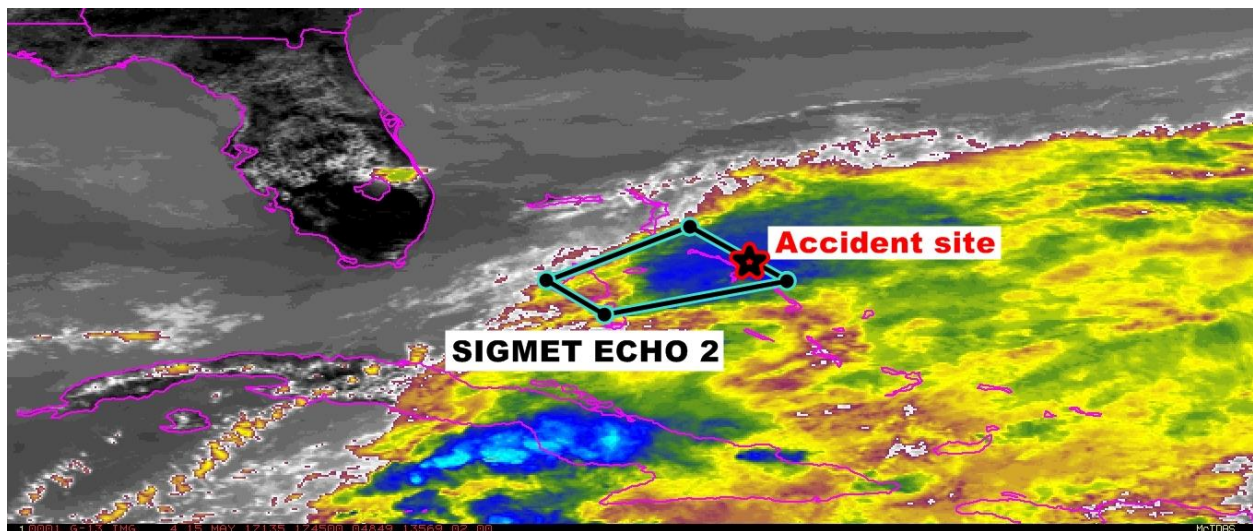


Figure 12 – SIGMET valid at the accident time

## 9.0 AIRMETs

No Airmen's Meteorological Information (AIRMET) advisories were valid for the accident site at the accident time nor would any AIRMETs be expected at that location, as it was outside of the forecast airspace for AIRMETs.

## 10.0 Area Forecast

The corrected Area Forecast issued at 1232 EDT, and valid at the accident time, forecasted scattered clouds at 3,000 feet with scattered clouds to a broken ceiling at 6,000 feet with tops layered above FL240. Widely scattered rain showers and thunderstorms were also forecast:

177

FACA20 KKCI 151632 CCA

OFAMKC

INTERNATIONAL OPERATIONS BRANCH

AVIATION WEATHER CENTER KANSAS CITY MISSOURI

VALID 151600-160400

OUTLOOK...160400-161600

. ATLANTIC S OF 32N W OF 57W...CARIBBEAN...GULF OF MEXICO BTN 22N AND 24N.

. ALL WND SFC. TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS. SFC TO 400MB.

. SYNOPSIS...

CDFNT FROM 34N70W TO 38N54W TO 26N75W TO 41N55W.

SFC TROF FROM 21N86W TO 20N88W.

IN WRN CARIB...SFC TROF FROM 19N79W TO 16N82W TO 12N83W.

IN CNTRL CARIB...TROPICAL WAVE FROM 15N74W TO 10N70W.

LARGE CLUSTER OF TSRA OVER SRN 1/2 OF KINGSTON FIR.

WDLY SCT TSRA OVER WRN PTN OF NRN PANAMA FIR AND SWRN CORNER OF KINGSTON FIR.

BRISK E TO SE WINDS OVER ERN CARIB...E OF 75W AND S OF 15N.

BRISK SWLY WINDS OVER NERN CORNER OF ATLC SWRN NEW YORK FIR.

. SIGNIFICANT CLD/WX...

ERN MONTERREY FIR...NRN MERIDA FIR

SE OF 25N75W TO 23N95E...SCT030 SCT-BKN060 TOP 130. OTLK...VFR.

ELSW...SCT030. OTLK...VFR.

### ATLC MIAMI FIR

NW 1/3...SCT030 SCT-BKN060. TOPS LYRD ABV FL240. WDLY SCT SHRA/TSRA. OTLK...VFR SHRA TSRA.

RMNDR...SCT020 OVC090 TOPS LYRD ABV FL240. ISOL SHRA. OTLK...VFR SHRA TSRA.

. ATLC SWRN NEW YORK FIR

N OF 31N...

W OF 50W...SCT030 SCT060. LYRS OCNL BKN TOP 150. WDLY SCT SHRA.

ISOL TSRA. OTLK...VFR SHRA TSRA.

RMNDR...

W OF 50W...SCT030 SCT-BKN060 TOP 150. ISOL SHRA/TSRA.

OTLK...VFR SHRA TSRA.

E OF 50W...SCT030 SCT060. OCNL BKN060 TOPS ABV FL240. ISOL SHRA. OTLK...VFR SHRA.

. SAN JUAN FIR...COR...

SCT030 SCT090. ISOL SHRA. OTLK...VFR SHRA.

.  
 WRN PIARCO FIR...NRN MAIQUETIA FIR...CURACAO FIR  
 SCT030 SCT060. ISOL SHRA. WND SE 20KT. OTLK...VFR SHRA WND.

.  
 NRN BARRANQUILLA FIR...NRN PANAMA FIR...COR...  
 W OF 80W...SCT020 SCT-BKN040 TOPS ABV FL240. WDLY SCT SHRA/TSRA.  
 OTLK...VFR SHRA TSRA.  
 E OF 80W...SCT020 SCT040. OTLK...VFR.

.  
 KINGSTON FIR  
 SCT020 SCT-BKN040 TOPS ABV FL240. WDLY SCT SHRA/TSRA. OTLK...VFR  
 SHRA TSRA.

.  
 NERN CNTRL AMER FIR  
 SCT020 SCT-BKN060 TOPS ABV FL240. ISOL SHRA. OTLK...VFR SHRA.

.  
 HABANA FIR  
 CUBA...SCT020 SCT-BKN060 TOP 150. WDLY SCT SHRA.  
 OTLK...VFR SHRA.  
 WTRS S OF CUBA AND E OF 81W...SCT015 SCT060.  
 LYRS OCNL BKN TOP ABV FL240. SCT SHRA/WDLY SCT TSRA.  
 OTLK...VFR SHRA TSRA.  
 WTRS ELSW E OF 80W...SCT030 SCT060. LYRS OCNL BKN TOP ABV FL240.  
 WDLY SCT SHRA/ISOL TSRA. OTLK...VFR SHRA TSRA.  
 WTRS W OF 80W...SCT030 SCT060. OCNL BKN060 TOPS ABV FL240. ISOL  
 SHRA.  
 OTLK...VFR SHRA.

.  
 SANTO DOMINGO FIR...PORT-AU-PRINCE FIR  
 HISPANIOLA...SCT020 SCT-BKN070 TOP FL200. WDLY SCT SHRA.  
 ISOL TSRA. OTLK...VFR SHRA TSRA.  
 WTRS NW OF 17N73W TO 20N70W OF HISPANIOLA...SCT030 SCT060. ISOL  
 SHRA. OTLK...VFR SHRA.  
 WTRS ELSW...SCT030 SCT060. LYRS OCNL BKN TOP 150.  
 WDLY SCT SHRA. OTLK...VFR SHRA.

.  
 ICE AND FRZLVL...  
 NO SGFNT ICE EXP OUTSIDE CNVTV ACT.  
 FRZLVL...  
 SRN GLFMEX.....150 TO 160.  
 CARIB... (S OF 20N)...150 TO 170.  
 WRN ATLC (N OF 20N)...120 NE TO 150-160 S.

.  
 TURB...  
 NO SGFNT TURB EXP OUTSIDE CNVTV ACT.  
 ....

## 11.0 Terminal Aerodrome Forecast

MYNN was the closest site to the accident site with a Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 1200 EDT and was valid for a 24-hour period beginning at 1200 EDT. The TAF for MYNN was as follows:

TAF MYNN 151600Z 1518/1618 **VRB02KT 9000 SHRA FEW015CB SCT020 BKN080**  
PROB40  
TEMPO 1518/1522 4800 TSRA SCT015CB BKN018=

The forecast expected a variable wind at 2 knots, 9 km<sup>22</sup> visibility, moderate rain showers, few cumulonimbus clouds at 1,500 feet agl, scattered clouds at 2,000 feet agl, and a broken ceiling at 8,000 feet agl.

## 12.0 Pilot Weather Briefing

A search of official weather briefing sources, such as Leidos and Lockheed Martin Flight Service and Direct User Access Terminal Service was done and the accident pilot did receive an official text weather briefing information from Leidos through ForeFlight before the accident flight. The accident pilot received the official weather briefing information at 0310 EDT and 0317 EDT (attachments 3, 4, and 5). The weather briefings requested not only provided the standard weather information for the intended route of the accident flight, but the accident pilot also requested an official weather briefing for a proposed flight from Titusville, Florida, (KTIK) to New York, New York, (KISP) for later on May 15. Since the accident pilot was using ForeFlight to receive the weather briefing information, the accident pilot could have viewed the weather information in a graphical format on an electronic flight bag (EFB). The exact images and graphical and text weather information that could have been viewed by the accident pilot on his EFB are available in attachment 6.

It is unknown if the accident pilot checked or received any more weather information before or during the accident flight.

## 13.0 Icing Potential<sup>23</sup>

Current Icing Potential (CIP) and Forecast Icing Potential (FIP) products are created by the NWS' Aviation Weather Center (AWC) and are intended to be supplemental to other icing advisories (e.g. AIRMETs and SIGMETs). Figures 13 through 15 present the FIP icing probabilities, FIP icing severity products, and FIP Supercooled Large Drops (SLD) potential 1-hour forecasts, respectively, which were valid at 1400 EDT at 23,500, 24,000, and 24,500 feet msl (similar values in the FIP are seen in the 2-hour forecast valid at both 1300 and 1400 EDT, attachment 7). The FIP indicated between a 10 to 30 percent probability of icing at 23,500, 24,000, and 24,500 feet at 1400 EDT at the accident site. The FIP also indicated that the icing near the accident site would likely be moderate to heavy (figures 13, 14, and 15). The FIP did indicate a 70 to 90 percent SLD potential just southwest of the accident area with unknown SLD potential directly over the accident site. This FIP information would have been available on the NWS AWC website before the accident flight departed.<sup>24</sup>

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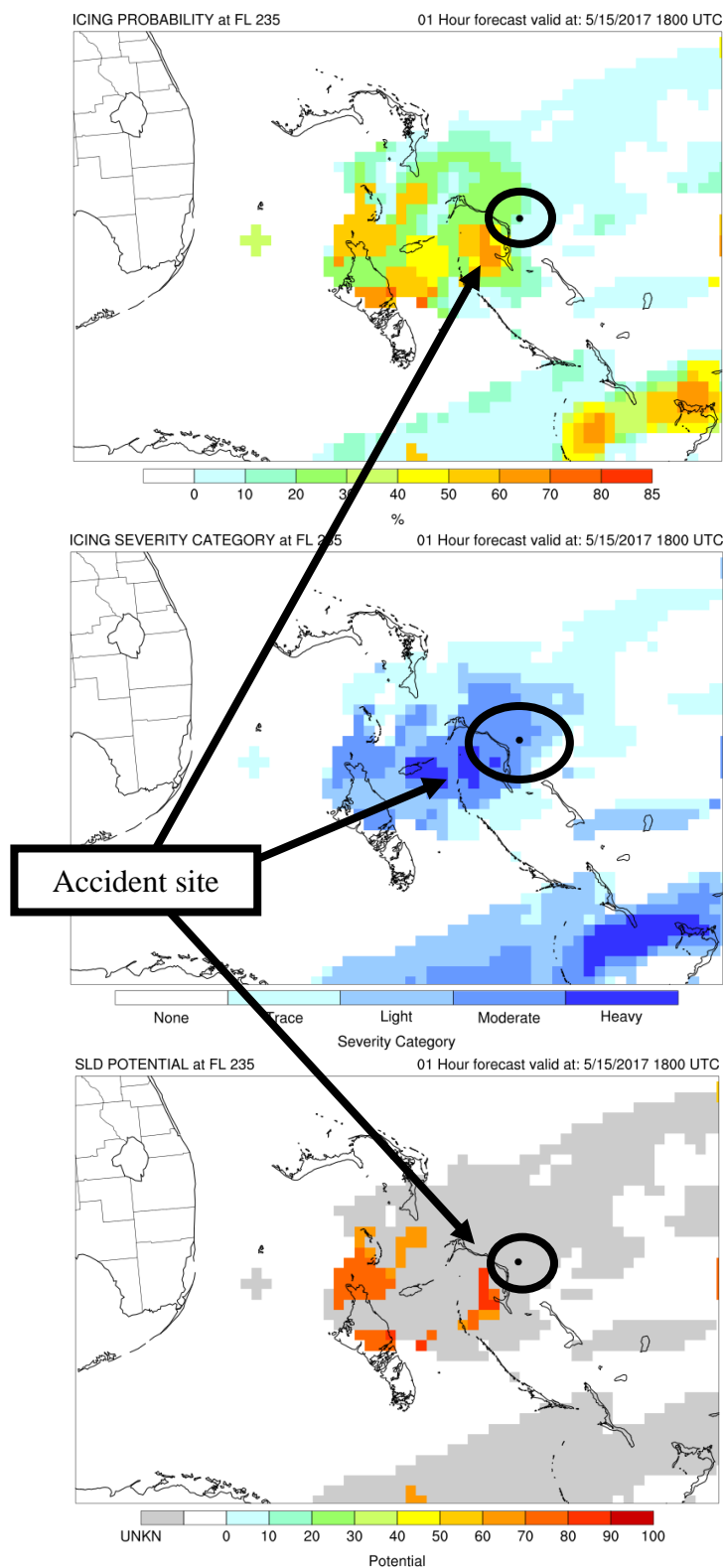
<sup>22</sup> 9 km  $\approx$  5.6 statute miles

<sup>23</sup> B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cuning, Current Icing Potential: Algorithm Description and Comparison with Aircraft Observations (Journal of Applied Meteorology, 2005), pp. 969-986.

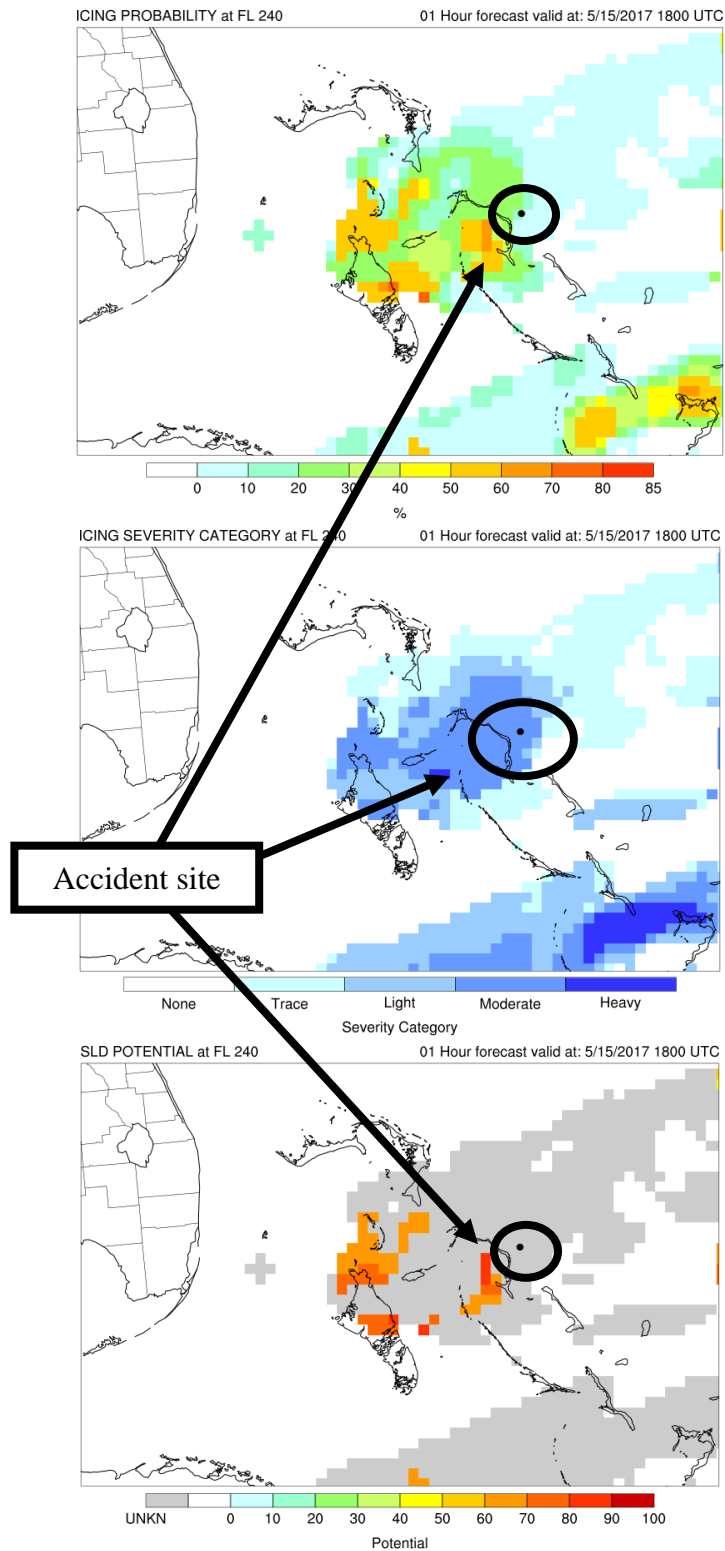
C.A. Wolff, F. McDonough, M. K. Politovich, B.C. Bernstein, and G. Cuning, FIP Severity Technical Document (Prepared for the Aviation Weather Technology Transfer Technical Review Board), pp. 1-44.

<sup>24</sup> <https://www.aviationweather.gov/icing/fip>

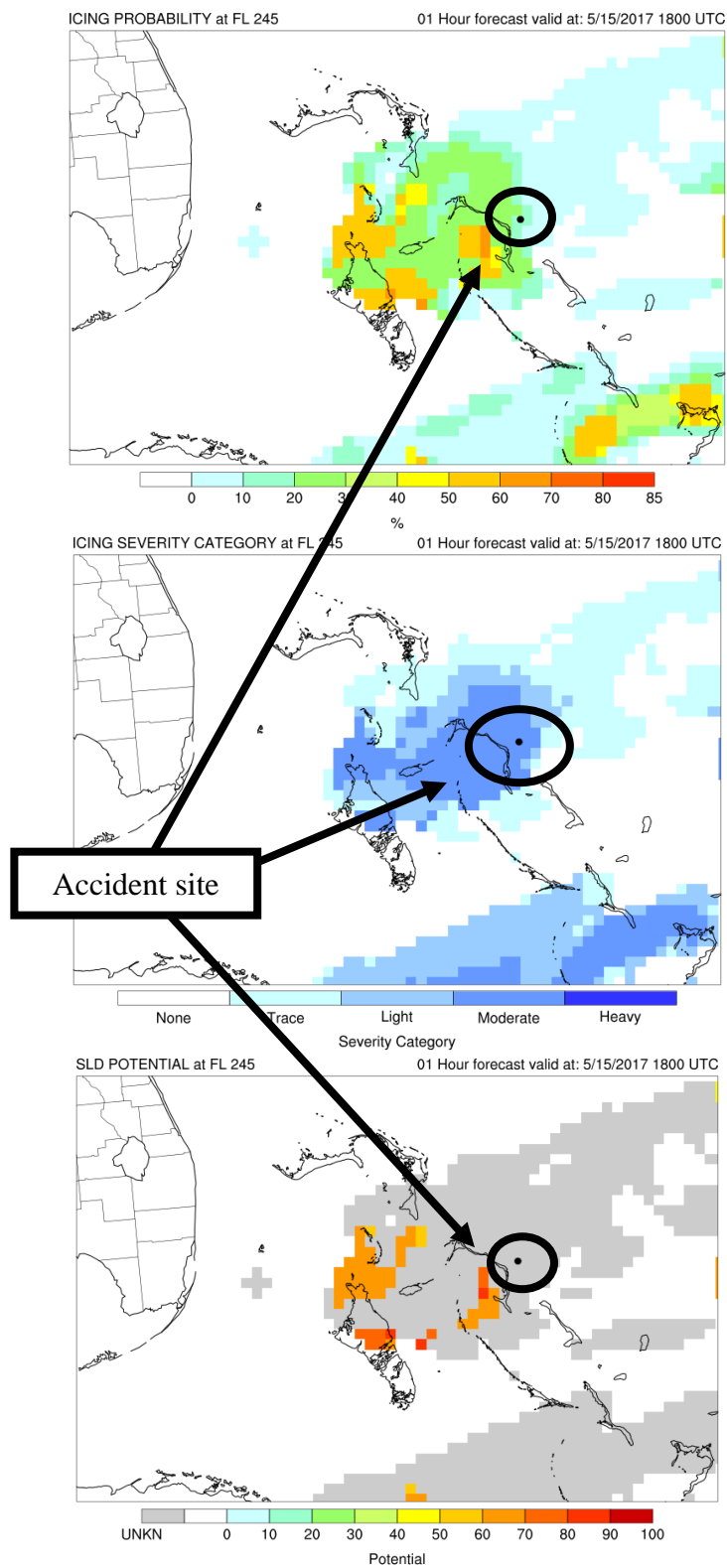
The CIP product indicated between a 10 to 30 percent probability of icing at 23,500, 24,000, and 24,500 feet at 1400 EDT at the accident site. The CIP also indicated that the icing near the accident site would likely be of moderate intensity (figures 16, 17, and 18). The CIP did indicate a 60 to 80 percent SLD potential just southwest of the accident area with unknown SLD potential directly over the accident site. While the probability of icing was not high, the FIP and CIP products indicated moderate or greater icing conditions and SLD were likely over the accident area at the accident time (figures 13 through 18 and attachment 7). For more FIP and CIP information and altitudes please see attachment 7.



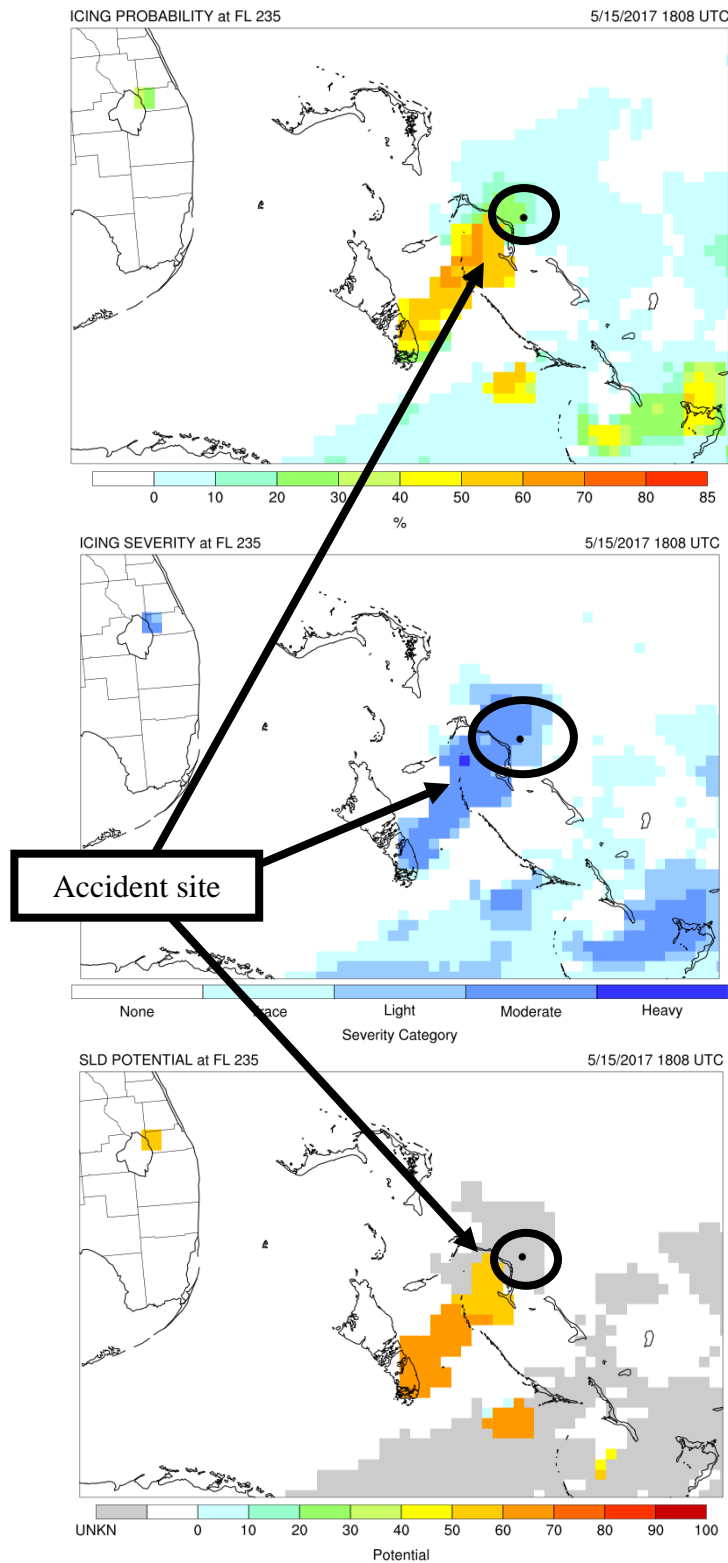
**Figure 13 – (top) FIP probability of icing at 23,500 feet msl, (middle) FIP severity of icing at 23,500 feet msl, (bottom) FIP probability of SLD at 23,500 feet msl 1-hour forecasts valid for 1400 EDT**



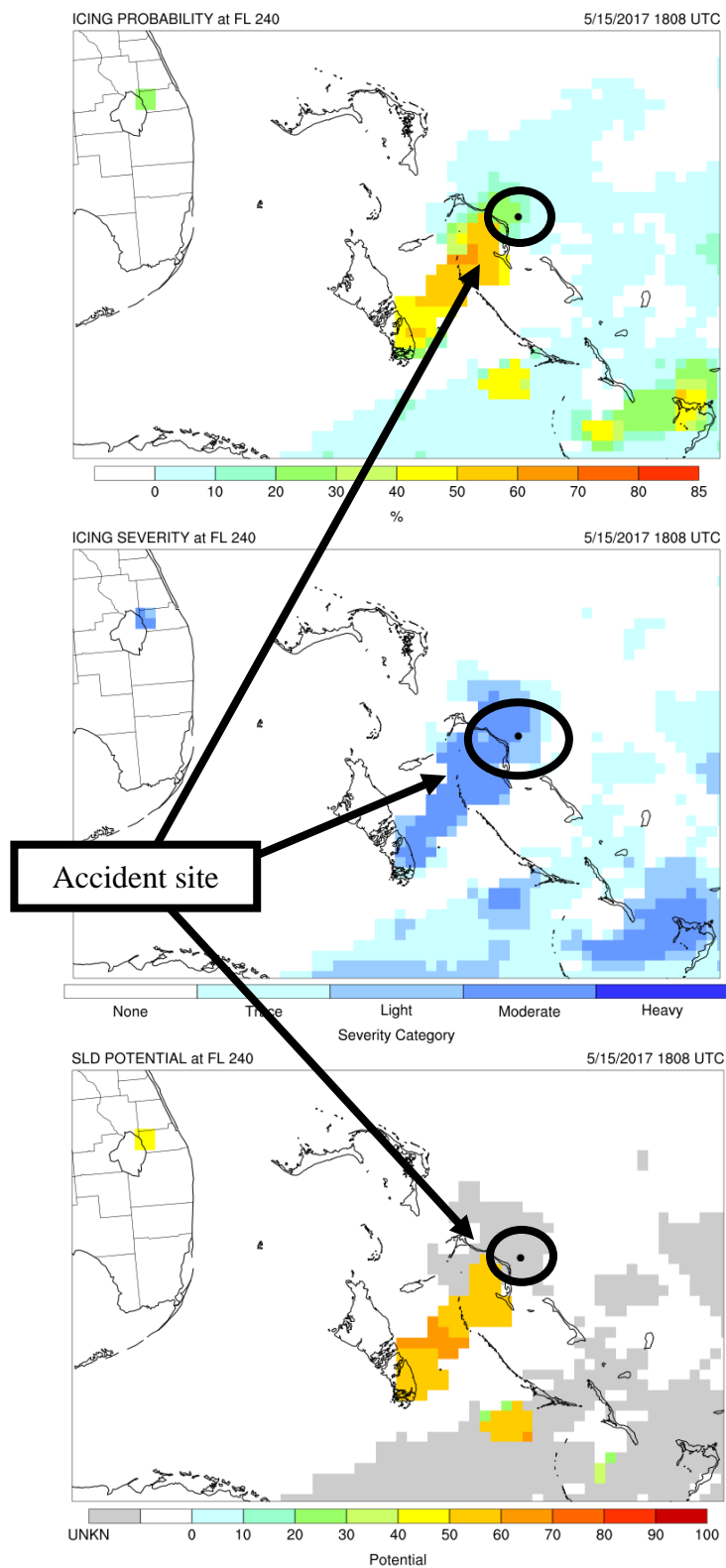
**Figure 14 – (top) FIP probability of icing at 24,000 feet msl, (middle) FIP severity of icing at 24,000 feet msl, (bottom) FIP probability of SLD at 24,000 feet msl 1-hour forecasts valid for 1400 EDT**



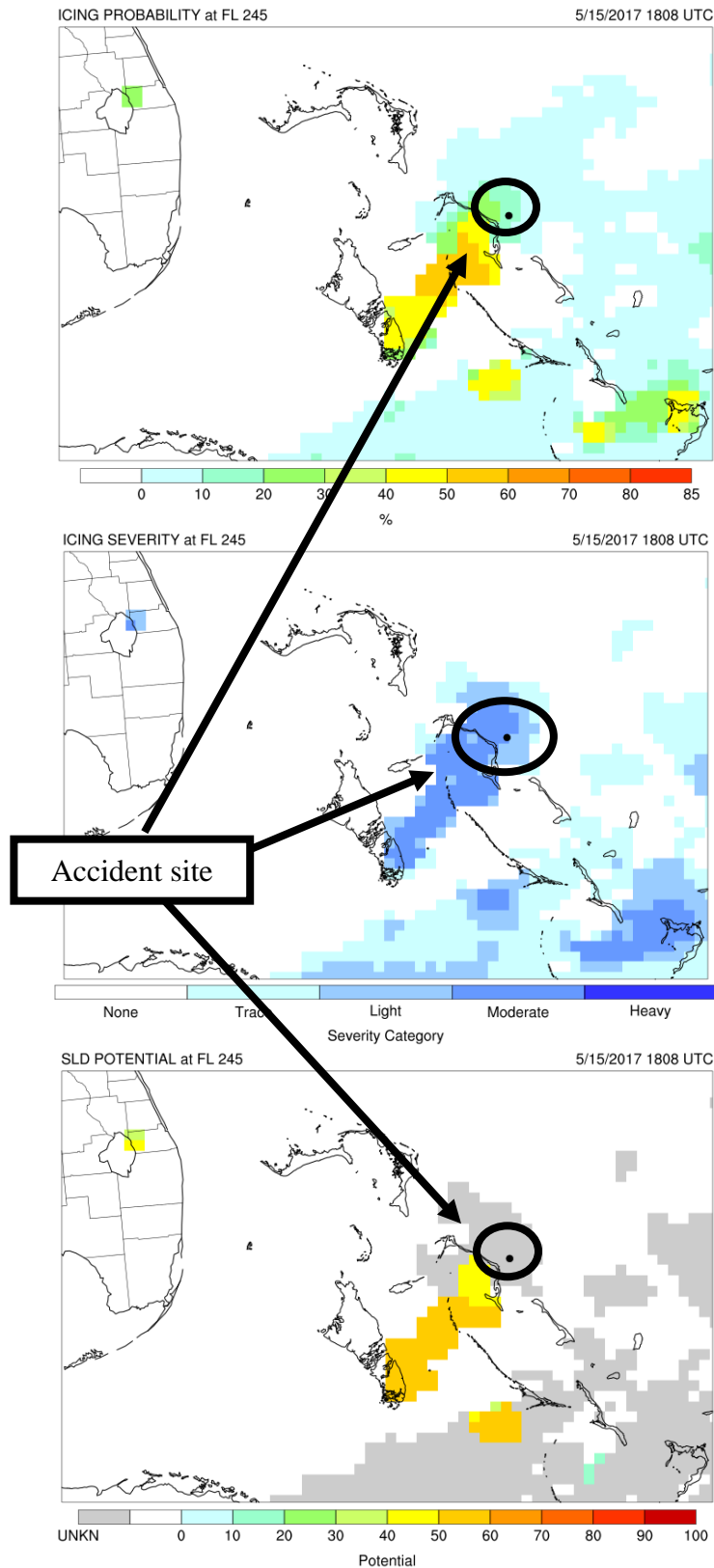
**Figure 15 – (top) FIP probability of icing at 24,500 feet msl, (middle) FIP severity of icing at 24,500 feet msl, (bottom) FIP probability of SLD at 24,500 feet msl 1-hour forecasts valid for 1400 EDT**



**Figure 16 – (top) CIP probability of icing at 23,500 feet msl, (middle) CIP severity of icing at 23,500 feet msl, (bottom) CIP probability of SLD at 23,500 feet msl valid for 1400 EDT**



**Figure 17 – (top) CIP probability of icing at 24,000 feet msl, (middle) CIP severity of icing at 24,000 feet msl, (bottom) CIP probability of SLD at 24,000 feet msl valid for 1400 EDT**



**Figure 18 – (top) CIP probability of icing at 24,500 feet msl, (middle) CIP severity of icing at 24,500 feet msl, (bottom) CIP probability of SLD at 24,500 feet msl valid for 1400 EDT**

## **14.0 Astronomical Data**

The astronomical data obtained from the United States Naval Observatory for the accident site on May 15, 2017, indicated the following:

### **SUN**

Begin civil twilight	0554 EDT
Sunrise	0619 EDT
Sun transit	1300 EDT
Sunset	1942 EDT
End civil twilight	2007 EDT

## **E. LIST OF ATTACHMENTS**

Attachment 1 – Animation of GOES-13 visible imagery from 1300 EDT to 1500 EDT

Attachment 2 – Animation of GOES-13 infrared imagery from 1300 EDT to 1500 EDT

Attachment 3 – Text Leidos weather briefing information from 0310 EDT

Attachment 4 – Text Leidos weather briefing information from 0317 EDT

Attachment 5 – Timeline of Leidos weather briefing information available for the accident pilot

Attachment 6 – Text and graphical ForeFlight Mobile weather briefing information from 0310 and 0317 EDT

Attachment 7 – CIP/FIP data for 1300 and 1400 EDT around the accident site

Submitted by:

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